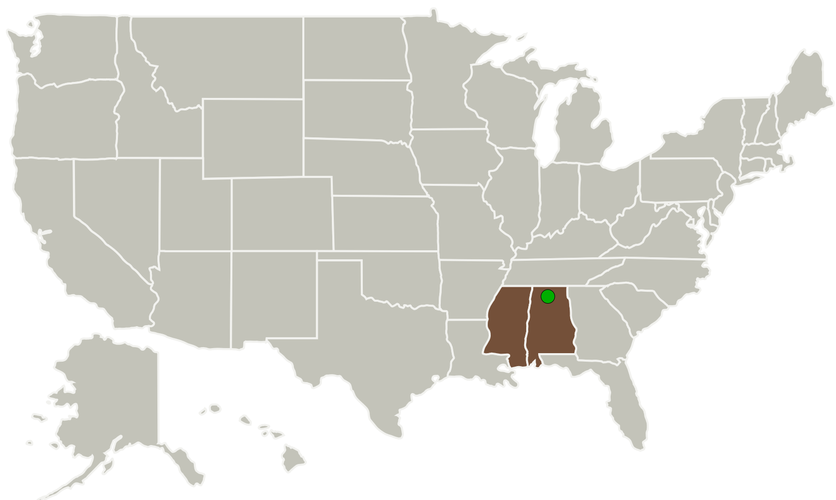
High-Fidelity Prediction of Launch Vehicle Lift-off Acoustic Environment, Phase I

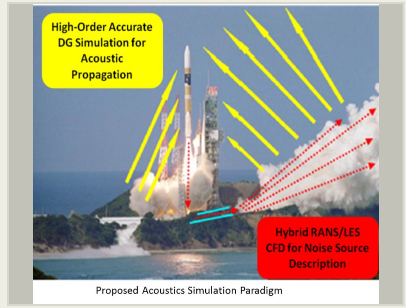
Completed Technology Project (2013 - 2014)

Project Introduction

Launch vehicles experience extreme acoustic loads during liftoff driven by the interaction of rocket plumes and plume-generated acoustic waves with ground structures. Currently employed predictive capabilities to model the complex turbulent plume physics are too dissipative to accurately resolve the propagation of acoustic waves throughout the launch environment. Higher fidelity liftoff acoustic analysis tools to design mitigation measures such as deluge water and launch pad geometry are critically needed to optimize launch pads for SLS and commercial launch vehicles. This STTR project will deliver breakthrough technologies to drastically improve predictive capabilities for launch vehicle lift-off acoustic environments. Hybrid RANS/LES modeling presently established in NASA production flow solvers will be used for simulation of the acoustic generation physics, and a high-order accurate unstructured discontinuous Galerkin (DG) solver developed in the same production framework will be employed to accurately propagate acoustic waves across large distances. An innovative hybrid CFD-CAA method will be developed in which the launch-induced acoustic field predicted from hybrid RANS/LES will be transmitted to a DG solver and propagated using high-order accurate schemes ideal for acoustic propagation modeling. This new paradigm enables: (1) Improved fidelity over linear methods for modeling nonlinear launch-induced acoustics; (2) Greatly reduced numerical dissipation and dispersion; and (3) Improved acoustics modeling for attenuation, reflection, and diffraction from complex geometry. The merits of the proposed approach will be investigated and demonstrated in Phase I for benchmark CAA applications and plume impingement problems. In Phase II, the methodology will be refined and validated against realistic targeted applications.

Primary U.S. Work Locations and Key Partners





High-Fidelity Prediction of Launch Vehicle Lift-off Acoustic Environment

Table of Contents

Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Mississippi

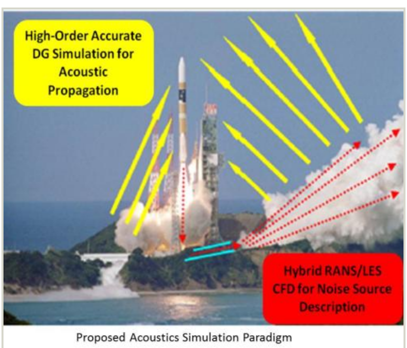
Project Transitions

May 2013: Project Start

May 2014: Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/140468)*

Images



Project Image
High-Fidelity Prediction of Launch Vehicle Lift-off Acoustic Environment
(https://techport.nasa.gov/image/134556)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

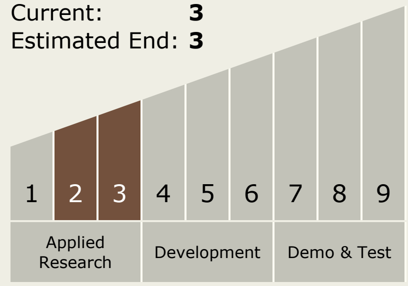
Robert E Harris

Co-Investigator:

Robert J Harris

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.1 Chemical Space Propulsion
    └ TX01.1.2 Earth Storable

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System